PROC. ENTOMOL. SOC. WASH.
99(4), 1997, pp. 623–627

EMPOASCA (KYBOS) LUDA DAVIDSON AND DELONG: DISTRIBUTION AND HABITS OF AN IMMIGRANT BIRCH-FEEDING LEAFHOPPER IN NORTH AMERICA (HOMOPTERA: CICADELLIDAE)

A. G. WHEELER, JR.

Department of Entomology, Clemson University, Clemson, SC 29634, U.S.A.

Abstract.—The typhlocybine leafhopper *Empoasca* (*Kybos*) *luda* Davidson and DeLong, though first described from the United States, is believed to be a native European species that has been accidentally introduced into North America. New state records are given for Maryland, New York, and Pennsylvania. Overwintering occurs in the egg stage, and first-generation adults appear from late May through June; a second generation is produced in mid- to late summer. Nymphs feed on lower leaf surfaces of European white birch (*Betula pendula* Roth) in landscape plantings, causing chlorosis on the upper surfaces. Taxonomic characters are provided that allow this minor pest to be distinguished from a generally more serious pest of ornamental birches, the often co-occurring potato leafhopper, *E. fabae* (Harris).

Key Words: Insecta, Cicadellidae, leafhoppers, distribution, birches, feeding habits

Empoasca (*Kybos*) *luda* Davidson and DeLong is a West European typhlocybine leafhopper considered to have been accidentally introduced into the Nearctic Region (Hamilton 1972, 1983, Hamilton and Langor 1987). First collected in North America in 1917 (Davidson and DeLong 1938), this birch feeder has remained little known. Here, I review its taxonomic history, give new U.S. records, and provide notes on its seasonality and habits on ornamental birches. Characters are also provided that facilitate the recognition of *E. luda* on birch trees.

TAXONOMIC HISTORY

Though regarded as adventive in the New World, *E. luda* was first described from North America; Davidson and DeLong (1938) based their description on single specimens from Illinois and Ohio. In Europe, Wagner (1955) described the new species *E. betulicola* from Germany, noting that it superficially resembles the Palearctic *E. smaragdula* (Fallén). Hamilton (1983), recognizing that the birch-feeding species described by Wagner is conspecific with that described by Davidson and DeLong, proposed *E. betulicola* as a synonym of *E. luda*. Ross (1963) incorrectly synonymized *E. luda* under *E. smaragdula* (P. W. Oman, pers. comm. 1989), which specializes on alders (*Alnus* spp.) (e.g., Nuorteva 1952, Le Quesne 1960, Claridge et al. 1968, Claridge and Wilson 1976, Dworakowska 1976, Ossiannilsson 1981).

Empoasca luda has been confused with *E. smaragdula* in both Europe and North America. Apparently the only valid Nearctic record of the latter species is that of Hamilton (1983) from Vancouver, B.C. The records of Poos and Wheeler (1943), who referred to *E. smaragdula* as widely distributed in Canada and occurring throughout the United States, are based on misidentifications (see Hamilton 1983). Their listing

of alder, birch, crabapple, linden, poplar, and willow as host plants suggests that several *Empoasca* species, including *E. luda,* are contained in their concept of *E. smaragdula.* Based on Hamilton (1983, 1985), Beirne's (1956) record of *E. smaragdula* from Ontario is also misidentified and refers to *E. luda.*

Kybos and other subgenera of *Empoasca* are sometimes given generic status (e.g., Dlabola 1958, Le Quesne 1960). Here, however, I follow Ossiannilsson (1981), Hamilton (1983), and others who consider *Kybos* a subgenus of *Empoasca.*

North American Distribution

In addition to Illinois and Ohio (Davidson and DeLong 1938), *E. luda* is known from Connecticut, Minnesota, Ontario, and Virginia (Metcalf 1968). Subsequent to the Metcalf catalogue, it has been reported from British Columbia, Ontario (Hamilton 1972, 1983), and Newfoundland (Hamilton and Langor 1987). The following new state records are based on my collections from ornamental *Betula pendula* Roth. Voucher specimens have been deposited in the collections of Cornell University, Ithaca, N.Y.; National Museum of Natural History, Washington, D.C. (USNM); and the Pennsylvania Department of Agriculture, Harrisburg.

MARYLAND: *Allegany Co.,* Frostburg State University, Frostburg, 28 July 1989, 9 May 1990, 3 June 1990; Frostburg, 23 May 1993 (nymphs only); Zihlman, 28 July 1989. NEW YORK: *Tompkins Co.,* Ithaca, 29 Aug. 1989. PENNSYLVANIA: *Berks Co.,* Kutztown University, Kutztown, 18 Aug. 1989; *Huntingdon Co.,* Greenwood Furnace, 28 June 1990; *Lehigh Co.,* Trexlertown, 8 Aug. 1989; *Luzerne Co.,* Wilkes-Barre, 14 Aug. 1989; *Northampton Co.,* Cherryville, 8 Aug. 1989.

Empoasca luda has been recorded from northern Virginia (Arlington) by Wheeler (1942). I have collected it on *B. pendula* in southwestern Virginia (Montgomery Co., Virginia Tech campus, Blacksburg, 2 July 1995), which is the southernmost record of this adventive leafhopper in North America.

Seasonal History, Hosts, and Habits

Notes on seasonality are based on collections and observations of small numbers of individuals (often 10 or fewer) made periodically from European white (or silver) birch (*B. pendula*), the white-barked birch most commonly planted as an ornamental in the United States. In the horticultural trade, this species, as well as the European *B. pubescens* Ehrh., has often been called *B. alba* L. (Santamour and McArdle 1989). At Trexlertown, Pa., *E. luda* was found on a cut-leaved, pendulous birch, probably *B. pendula* 'laciniata'.

The collection of second-and third-instar nymphs in early May in western Maryland suggests that *E. luda* overwinters in the egg stage, as does *E. smaragdula* and apparently other members of the subgenus *Kybos* (Nuorteva 1952, Ossiannilsson 1981). Fourth instars were observed in late May, and in early June about equal numbers of late-instar nymphs and adults were present at Frostburg, Md. In Pennsylvania, adults and late instars of a first generation were found in late June. The collection of nymphs in early to mid-August in Pennsylvania and in late August in New York suggests the occurrence of two generations on ornamental birches. At Arlington, Va., adults have been collected as late as 8 Oct. (USNM collection). This leafhopper is also thought to be bivoltine in Europe (Dworakowska 1976).

Nymphs occur mainly on the abaxial surface of birch leaves, their feeding on mesophyll producing chlorosis on the adaxial surface (Fig. 1). In early season, and when relatively small numbers of *E. luda* are present, the injury consists of light stippling. Only in western Maryland in 1989 was chlorosis conspicuous on the foliage of European white birch.

Recognition Features

Wild and cultivated birches, including *B. pendula,* serve as hosts of numerous leaf-

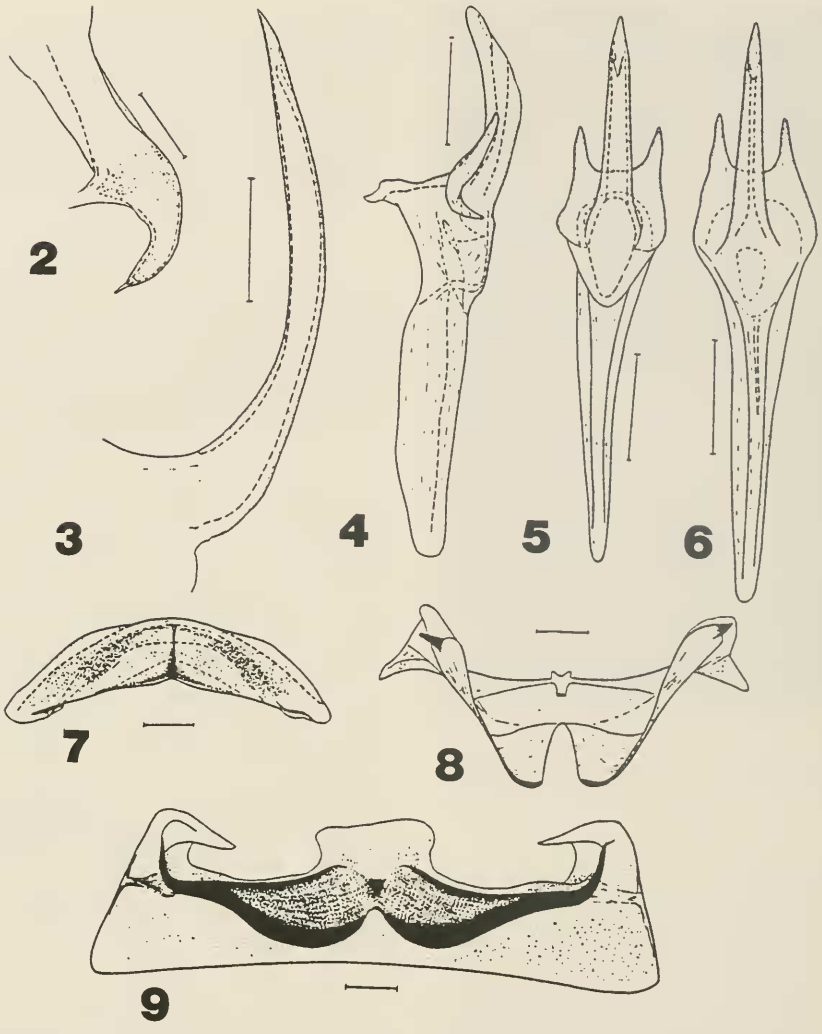
Fig. 1. Chlorosis on foliage of *Betula pendula* caused by the mesophyll-feeding leafhopper *Empoasca* (*Kybos*) *luda*.

hoppers in North America (Varty 1967, Hamilton 1985), but *E. luda* is larger (4.2–4.8 mm) than most other birch-feeding typhlocybines, and it is the only cicadellid species likely to occur on European white birch that has greenish and brown- or black-tinged forewings. Hamilton (1985) noted that adults are green or orange with black stripes, but all specimens I have seen are green or yellowish green with dark markings. *Empoasca fabae (Harris),* the potato leafhopper, frequently co-occurs with *E. luda,* but it is more delicate and smaller (about 3.0–3.5 mm), generally pale green without dark markings, and has a bluntly angled (rather than broadly rounded) vertex. Although *E. luda* has a distinctive habitus among leafhoppers associated with ornamental white birch, it cannot be separated reliably from other typhocybines, especially other members of the diverse genus *Empoasca,* without examining the male genitalia (Figs. 2–9). Male genitalic characters allowing *E. luda* (as *E. betulicola*) to be distinguished from the presumed closely related *E. smaragdula* are discussed and illustrated in LeQuesne (1961), Dworakowska (1976), and Ossiannilsson (1981).

Discussion

Empoasca luda is one of the relatively few Old World insects now established in the New World that was first described from North America; the mullein thrips, *Haplothrips verbasci* (Osborn), is believed to represent a similar example (Stannard 1968). The birch specialist *E. luda* is one of numerous Palearctic leafhoppers suggested to have been accidentally introduced into North America with shipments of nursery stock (Hamilton 1983, Hamilton and Langor 1987). The adventive status of *E. luda* in the Nearctic region is supported by my failure to collect this species in northeastern North America on native birches such as *B. lenta* L., *B. papyrifera* Marsh., or *B. populifolia* Marsh. Within the Holarctic subgenus *Kybos,* an association with *Alnus* and *Betula* (Betulaceae) is considered secondary, the ancestral hosts belonging to either *Populus* or *Salix* (Salicaceae) (Ross 1963).

Empoasca luda has not been reported previously as a pest of ornamental birches. As a mesophyll feeder, it causes chlorosis on the foliage of European white birch. Chlorosis is typically restricted to relatively few branches, although in 1989 injury was widespread on three trees in a Maryland landscape planting. Horticulturists, plant inspectors, and pest-management specialists, therefore, should be aware of this leafhopper's potential for causing aesthetic injury to European white birch. They should not, however, mistake *E. luda* for *E. fabae,* a mesophyll and occasional phloem feeder (e.g., Backus 1989) that can cause more serious problems on ornamental birches—stunting, distortion, and swelling of twigs—in nurseries and landscape plantings (Tashiro 1973, Valley and Blosser 1986, Johnson



Figs. 2–9. *Empoasca* (*Kybos*) *luda*, male terminalia. 2, Left anal collar appendage from left. 3, Left pygofer appendage from outside. 4, Aedeagus from left. 5, Aedeagus in ventral aspect. 6, Aedeagus in ventral aspect. 7, 2nd abdominal sternum from below. 8, 2nd abdominal tergum from above. 9, 3rd abdominal tergum from below. Scale = 0.1 mm (From Ossiannilsson 1981:436).

and Lyon 1988). I agree with Raupp (1990), who emphasized that managing arthropod pests of woody ornamentals depends on accurate identification of both the host plants and their arthropod associates, pests as well as beneficial and neutral species. *Empoasca luda* should be considered an occasional minor pest of European white birch.

Acknowledgments

I gratefully acknowledge E. R. Hoebeke (Cornell University) and P. W. Oman (Oregon State University) for confirming the identification of *E. luda*; T. E. Wolf (Pennsylvania Department of Agriculture) for photographing leafhopper injury; J. F. Stimmel (PDA) for preparing Fig. 1; T. J. Henry (Systematic Entomology Laboratory USDA) for checking the USNM collection for specimens of *E. luda*; P. H. Adler and J. C. Morse (Clemson University) for reviewing an early draft of the manuscript; and the publisher, E. J. Brill, Leiden, The Netherlands, for granting permission to re-

produce figs. 1394–1401 from Ossiannilsson's 1981 paper. This is Technical Contribution No. 4256 of the South Carolina Agricultural Experiment Station, Clemson University.

Literature Cited

Backus, E. A. 1989. Host acceptance and feeding behavior, pp. 10–17. *In* Armbrust, E. J. and W. O. Lamp, eds., Proceedings of a Symposium: History and Perspectives of Potato Leafhopper (Homoptera: Cicadellidae) Research. Entomological Society of America, Lanham, Md.

Beirne, B. P. 1956. Leafhoppers (Homoptera: Cicadellidae) of Canada and Alaska. Canadian Entomologist 88 (supplement 2): 5–177.

Claridge, M. F., J. M. Edington, and D. M. Murphy. 1968. The distribution of some Hemiptera in the birch-dominated woodlands of northern Scotland. Entomologist 101: 253–263.

Claridge, M. F. and M. R. Wilson. 1976. Diversity and distribution patterns of some mesophyll-feeding leafhoppers of temperate woodland canopy. Ecological Entomology 1: 231–250.

Davidson, R. H. and D. M. DeLong. 1938. Studies on the genus *Empoasca* (Homoptera, Cicadellidae). Part V. Twelve new species of *Empoasca* from the United States. Ohio Journal of Science 38: 90–96.

Dlabola, J. 1958. A reclassification of Palaearctic Typhlocybinae (Homopt., Auchenorrh.). Acta Societatis Entomologicae Cechosloveniae 55: 44–57.

Dworakowska, I. 1976. *Kybos* Fieb., subgenus of *Empoasca* Walsh (Auchenorrhyncha, Cicadellidae, Typhlocybinae) in Palaearctic. Acta Zoologica Cracoviensia 21: 387–463.

Hamilton, K. G. A. 1972. The leafhopper genus *Empoasca* subgenus *Kybos* in the southern interior of British Columbia. Journal of the Entomological Society of British Columbia 69: 58–67.

Hamilton, K. G. A. 1983. Introduced and native leafhoppers common to the Old and New Worlds (Rhynchota: Homoptera: Cicadellidae). Canadian Entomologist 115: 473–511.

Hamilton, K. G. A. 1985. Leafhoppers of ornamental and fruit trees in Canada. Agriculture Canada Publication 1779/E. 71 pp.

Hamilton, K. G. A. and D. W. Langor. 1987. Leafhopper fauna of Newfoundland and Cape Breton Islands (Rhynchota: Homoptera: Cicadellidae). Canadian Entomologist 119: 663–695.

Johnson, W. T. and H. H. Lyon. 1988. Insects that Feed on Trees and Shrubs, 2nd ed. Cornell University Press, Ithaca, N.Y. 556 pp.

LeQuesne, W. J. 1961. An examination of the British species of *Empoasca* sensu lato (Hem., Cicadellidae), including some additions to the British list. Entomologist's Monthly Magazine 96: 233–239.

Metcalf, Z. P. 1968. General Catalogue of the Homoptera. Fascicle VI Cicadelloidea, Part 17 Cicadellidae. Agricultural Research Service, U.S. Department of Agriculture, Washington, D.C. 1513 pp.

Nuorteva, P. 1952. Die Nahrungspflanzenwahl der Insekten im Lichte von Untersuchungen an Zikaden. Annales Academiae Scientiarum Fennicae IV Biologica 19(A): 1–90.

Ossiannilsson, F. 1981. The Auchenorrhyncha (Homoptera) of Fennoscandia and Denmark. Part 2: The families Cicadidae, Cercopidae, Membracidae, and Cicadellidae (excl. Deltocephalinae). Fauna Entomologica Scandinavica 7(2): 223–593.

Poos, F. W. and N. H. Wheeler. 1943. Studies on host plants of the leafhoppers of the genus *Empoasca*. U.S. Department of Agriculture Technical Bulletin 850. 51 pp.

Raupp, M. J. 1990. Recognizing the larvae of key pests and beneficials found on woody landscape plants. Journal of Arboriculture 16(3): 49–54.

Ross H. H. 1963. An evolutionary outline of the leafhopper genus *Empoasca* subgenus *Kybos*, with a key to the Nearctic fauna (Hemiptera, Cicadellidae). Annals of the Entomological Society of America 56: 202–223.

Santamour, F. S., Jr. and A. J. McArdle. 1989. Checklists of cultivars in *Betula* (birch). Journal of Arboriculture 15: 170–176.

Stannard, L. J. 1968. The thrips, or Thysanoptera, of Illinois. Illinois Natural History Survey Bulletin 29(4): 215–552.

Tashiro, H. 1973. Evaluation of soil applied systemic insecticides on insects of white birch in nurseries. Search Agriculture. Entomology (Geneva, New York) 3(9): 1–11.

Valley, K. and W. E. Blosser, Jr. 1986. Potato leafhopper, *Empoasca fabae* (Harris), as a pest of ornamentals (Homoptera: Cicadellidae). Regulatory Horticulture 12(2): 11–12.

Varty, I. W. 1967. Leafhoppers of the subfamily Typhlocybinae from birches. Canadian Entomologist 99: 170–180.

Wagner, W. 1955. Neue mitteleuropäische Zikaden und Blattflöhe (Homoptera). Entomologische Mitteilungen. Zoologischen Staatsinstitut und Zoologischen Museum (Hamburg) No. 6: 1–34.

Wheeler, N. H. 1942. Trap-light studies on leafhoppers of the genus *Empoasca* (Homoptera: Cicadellidae), 1932–1941. Proceedings of the Entomological Society of Washington 44: 69–72.